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AUTHOR Jones, Beau Fly
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ABSTRACT

Defining reading as a constructive process involving an interaction of the reader, the text, and the context, this paper offers a model of student cognitive processing that incorporates research in reading, thinking, teaching, and instructional materials. The first section of the paper provides the theoretical context for developing the model, while the second section defines the new model for reading in terms of four stages of comprehending and responding to text: before reading, during reading, after reading, and in response to questions. The third section outlines the characteristics of readers that influence their capacity to construct meaning from text and become independent learners, and the fourth section describes the characteristics of texts that may aid or hinder comprehension. The fifth section of the paper considers elements of the context that influence comprehension and learning, including the teacher, the instructional setting, and the instructional methods. Specifically, this section examines decisions of teachers and administrators that heavily influence the interaction between the teacher, the text, and the reader. The final section discusses the implications of this model for research and practice. An 8-page reference list concludes the document. (Author/FL)

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STUDENT COGNITIVE PROCESSING OF TEXT-BASED INSTRUCTION:
AN INTERACTION OF THE READER, THE TEXT, AND THE TEACHER*+

Beau Fly Jones

North Central Regional
Educational Laboratory

July 1985

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**STUDENT COGNITIVE PROCESSING OF TEXT-BASED INSTRUCTION:
AN INTERACTION OF THE READER, THE TEACHER, AND THE TEXT**

Abstract

The paper is divided into six parts. Part 1 provides the theoretical context for developing a model of student cognitive processing of text-based instruction. Part 2 defines the new model for reading in terms of an interaction between the reader, the text, and the context. Part 3 outlines the characteristics of readers that influence their capability to construct meaning from text and become independent learners. Part 4 describes the characteristics of instructional materials that may aid or hinder comprehension. Part 5 considers elements of the context that influence comprehension and learning. Specifically, the latter examines key decisions that teachers and administrators make that heavily influence the interaction between the teacher, the text, and the reader. Part 6 outlines the interaction of the reader, the text, and the teacher in a summary graphic and discusses the implications of this model for research and practice.

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**STUDENT COGNITIVE PROCESSING OF TEXT-BASED INSTRUCTION:
AN INTERACTION OF THE READER, THE TEXT, AND THE TEACHER***

Part 1 Introduction

Theoretical Context

Recent research on student cognitive processing marks a new generation of research on effective teaching. Generally speaking, research on effective teaching previously has focused on understanding the teacher as an executive and manager in a demanding and complex social context (Berliner, 1984). This research has generated data about such critical issues as pacing, content coverage, grouping, and direct instruction. More recently, research on teaching has been guided by questions investigating the relationship between teacher behaviors, student cognitive processing, and student outcomes using what is referred to as the cognitive mediational response model (e.g., Winne & Mark, 1983; Wittrock, in press). According to proponents of this model, teachers influence learning by causing students to think and behave in particular ways during teaching. These events may influence student achievement. Thus, the effects of teaching are mediated by the students' behavior and thoughts during instruction. Further, this strand of research has begun to look to cognitive science for models of learning and instructional strategies that influence comprehension. What is missing in this model is an account of student cognitive processing of text-based instruction.

At the same time, a parallel process appears to be occurring in research on higher order thinking. Examination of recent analyses (e.g., Nickerson, Perkins, & Smith, in press; Segal, Chipman, & Glaser, 1985) suggests that thinking skill programs and research on thinking contain few references to text-based instruction. Generally, the models of learning used in this strand of research derive heavily from information-processing theory and artificial intelligence, rather than acquisitions of text-based instruction or instruction oriented to processing text-based information.

How important are instructional materials in most classrooms? The

* I wish to acknowledge my appreciation to Jere Brophy, Lawrence Friedman, Margaret Tinzmann, and Allen Zondlak for their comments on earlier versions of this paper.

answer from diverse areas of research is "a lot" (e.g., Fisher, Berliner, Filby, Marliave, Cahen, Dishaw, & Moore, 1978). Estimates in reading, social studies, and science indicate that a staggering 70-90 percent of instruction in classrooms at most grade levels is text based. Given that many, if not most, thinking skill programs involve commercial texts, it seems likely that instruction in such courses would be heavily text based as well. The predominance of text in all these subjects makes it imperative to understand how students process content texts and the instructional materials that accompany them. It is also imperative to understand the teacher behaviors that help students comprehend and think about text-based information. Yet research on thinking, like research on teaching in the student cognitive processing model, has not systematically examined the relationship between the teacher, the reader, and the text.

Purpose

What is needed, given the gaps in research identified above, is to generate a model of student cognitive processing of text-based instruction that would integrate (1) research on reading and thinking from cognitive science, (2) research on instructional materials, and (3) the new research on student cognitive processing from effective teaching. Thus, this paper does not purport to be a comprehensive review of research on instruction. Rather, the aim here is to develop a cohesive conceptual framework that draws on key concepts from all three strands of research as well as concepts derived from practice. Such a model has implications for research and practice.

Nothing in this model is new. Elements of it have been discussed by many researchers. The problem is that in many instances, the focus is narrow, on one element or another of reading, writing, thinking, or teaching. Or, the focus is on research with little consideration of practice or practical concerns that impact on comprehension. In contrast, the unit of analysis here is not the act of comprehension but rather the act of completing an assignment or lesson. This includes comprehending the text, as well as in-depth study and responses to questions after reading. Additionally, key decisions about building organization and instructional delivery are considered as contextual factors that influence processing. Finally, the model presented here is integrative in that it welds together research on reading comprehension and writing, research on learning strategies and higher order thinking, and

research on text analysis and design and principles of instructional design to provide a holistic picture of student cognitive processing.

Part 2 Key Features of the Model

Definition of Reading

The definition of reading that arises from schema theory (see R.C. Anderson & Pearson, 1985) is that meaning is not contained in the text. It is not enough for the reader merely to decode the words in order to determine their meaning. Rather, reading involves an interaction of the reader, the information suggested in the text, and the characteristics of the context (R. C. Anderson, Spiro, & M.C. Anderson, 1978). More specifically, information is stored in the mind in terms of schemata or knowledge structures. To comprehend, the reader must activate the appropriate knowledge structures to interpret the meaning of the text and alter the existing knowledge structures accordingly. The readability of the text and familiarity of the topic will greatly influence this process. Thus, reading is a highly constructive and interactive process. The goal of reading, therefore, is to construct meaning from text.

The Process: Four Stages of Comprehending and Responding to Text

The process of constructing meaning from text consists of three stages: before reading, during reading, and after reading. That is, the reader engages in different activities before, during, and after reading. Various authors have defined these activities (e.g., T.H. Anderson, 1980; Collins, Brown, & Larkin, 1980; Herber, 1978; Tierney, 1983; Wixson & Peters, 1984). Additionally, in responding to essay questions about the text, the student progresses through various phases of planning, drafting, editing, and revising of written responses (D.H. Graves, 1978).

Before Reading Before reading, the model reader may use any of a variety of strategies to link the new information to prior knowledge and to comprehend the gist of what the text will contain. These strategies include: mentally reviewing previously acquired information; skimming the title, headings, sub-headings, questions, and graphics; making hypotheses or predictions about the text's content or structure; self-questioning; linking new vocabulary to synonyms and associated words; and so on. All of these strategies activate

existing schemata or knowledge structures. Further, the reader determines the purpose of reading, such as for pleasure or for information, in order to plan an appropriate rate of reading and appropriate strategy use (e.g., notetaking).

During Reading In this stage, the reader begins to refine earlier predictions and hypotheses as new information is obtained. The reader also notes what is important and unimportant, what is clear and not clear, and possibly what analogies are relevant to the content at hand. And, depending on the purpose, the reader may use any of several strategies to encode and recall what is read: generative underlining (Rickards & August, 1975), inferring the main idea (Pearson & Leys, in press; Wittrock, 1983), elaborating the text (Weinstein & Mayer, in press), forming analogies (Alexander & White, 1984; Sternberg, 1977), answering the questions associated with the text (e.g., Brown & Palincsar, in press) and so on. The reader may also engage in any number of innovative notetaking activities such as matrix outlining (Jones, Amiran, & Katims, 1985).

It is also in this stage that readers make evaluations regarding word meaning: Is a given word important? Can it be defined in the immediate context? In the distant context? Is it important enough to disrupt reading and look up the word or words in a dictionary? For words whose meaning is given, the reader may use various strategies to link the new word to prior knowledge, such as looking for a synonym or visualizing.

After Reading After-reading activities, like during-reading activities, depend on the purpose for reading. If the information is not to be processed in depth, memorized, or assessed for comprehension and retention, there may be few after-reading activities. If it is to be learned, the reader may engage in any number of activities to study in depth what was read and/or to monitor his or her own comprehension. Here the reader might outline or summarize the text, look back to check for mislearning, or reread what was unclear (e.g., Winograd, 1984).

In Response to Questions In many instances, teachers and students may move on to another topic or assignment when the after-reading activities are completed. At other times, the teacher will assign questions to assess what the student has learned and, sometimes, to facilitate comprehension and/or writing skills. Whatever the reason for the assignment, responses to questions are often a part of the reading/thinking process. At this point, I must become practical. I realize that throughout the country, the emphasis in writing

instruction is largely process oriented (e.g., Applebee, 1981). While I fully support this emphasis in the context of language arts courses, it seems less defensible in the context of content courses. To explain, it is important to make the distinction between learning to write and writing to learn, obviously analogous to the distinction between learning to read and reading to learn (Herber, 1978). In learning to write, the focus of instruction should be process oriented.

However, it is important to make the case here for being product oriented in instances of writing to learn when the student is expected to complete essay questions containing specific information and text structures in literature and other content courses. In observing instruction in some of the most outstanding public and private schools in the country, it is evident to me that good teachers provide what I term **response instruction** (Jones, in press). Such teachers have in mind very specific content and text structure objectives when they give essay assignments (e.g., compare/contrast two characters or situations in a novel). Moreover, teachers communicate these ideas to the students in various ways: course objectives, handouts, verbal explanations, modeling, comments on exam questions, and so on. I have even seen teachers provide explicit essay writing instructions before testing. In my opinion, these efforts are to be commended because writing objectives are often, if not usually, a hidden agenda in content courses as well as in language arts courses.

Thus, what I call response instruction has two elements: **product specification** and **process specification**. Product specification includes an overall or general definition of specific text structures to be emulated as well as definition and modeling of the types of sentences and information that make up such structures. Process specification includes references to planning, drafting, sharing, editing, and revising.

To summarize, constructing meaning from text involves various thinking processes before reading, during reading, immediately after reading and in responding to questions about the text. This conceptualization raises key questions about the relationship between reading and thinking, on the one hand, and the nature of instruction, on the other hand. It also raises questions about the characteristics of the reader, the text, and the context that influence reading, thinking, writing, and instruction.

Reading and Thinking

What is the connection between this model of reading and responding to questions and extant models of thinking? First, it seems evident from the foregoing that for good readers reading and responding to questions is thinking, specifically higher order thinking including inferencing, deductive and inductive reasoning, analysis, translations, applications, summarizing, critical thinking, and syntheses. Thus, this model involves many if not most of the skills defined by Bloom et al. (1956) and others purporting to have taxonomies of thinking (e.g., Feuerstein, 1980).

Second, the obverse is often true: thinking often involves reading and comprehension when the problems involve texts, as they so often do in many thinking skills courses (as well as in science and math courses or even art and music, for that matter). But even when there is no text, solving problems, categorizing, deductive and inductive reasoning, and other "thinking" skills involve comprehension. Part of the process of problem solving, for example, is constructing the meaning of the problem and finding meaningful solutions. Or consider categorizing. In order to categorize, the learner must comprehend the meaning of each example or item and the relationships among them, i.e., their similarities and differences.

A third connection between models of reading and models of thinking concerns the concept of depth of processing (Craik & Lockhart, 1972). To explain: there is very strong evidence that depth of processing influences comprehension—the greater the depth of processing, the greater the level of comprehension, and the greater the retention (Bransford & Johnson, 1972; Jenkins, 1974; Rood & Weinstein, 1983). Furthermore, according to Beck's (1985) analysis of vocabulary instruction in training studies, the specific strategy used or taught does not seem to matter as long as it requires the student to process word meanings and their relationships in depth.

These findings raise the question: What defines depth of processing? According to Rood & Weinstein (1983), there is considerable disagreement about the specific definition of the concept of depth of processing and levels of thinking. While it is not within the scope of this paper to review these arguments, there is ample evidence from this strand of research that specific teaching/learning strategies vary greatly in their capability to influence inferential comprehension and long-term memory. Further, these studies suggest that there are levels of thinking, even though researchers have yet

to agree on their parameters, and that the more thinking involved in information processing, the better it is comprehended and remembered.

Model of Instruction

If comprehension is a process that involves different thinking processes at different stages of reading—including responding to questions—before, during, and after reading, then instruction should assist the reader at each of these stages (T.H. Anderson, 1980). Specifically, instruction, whether it is provided in the materials and/or by the teacher, should assist the reader in constructing meaning from text and seek to teach the reader to become an independent learner at each stage in the learning process. This means, in many instances, that instruction should teach readers a repertoire of reading and encoding strategies to use before and during reading, as well as in-depth study or learning strategies and writing skills to use after reading. Additionally, instruction should provide opportunities to learn which strategy is most appropriate for a given task or text condition and should give the criteria by which students will be judged, and judge themselves.

Given these assumptions about the definition of reading and the process of constructing meaning from text, it is important to return to the issue posed earlier. What knowledge and skills do teachers, curriculum designers/developers, and administrators need in order to help students construct meaning from text? Clearly, it is critical for educators to understand the new definition of reading. It is also vital for them to understand the characteristics of the reader, the characteristics of the text, and the characteristics of context that influence comprehension of text-based instruction.

Part 3 Characteristics of the Reader

Prior Knowledge

Content Knowledge The research on reading emphasizes heavily the importance of prior knowledge of the topic in constructing meaning from text (e.g., R. C. Anderson & Pearson, 1984). This emphasis refers back to the assumption from schema theory that most learning involves subsumption or assimilation of new information into existing knowledge structures (Rumelhart, 1980). Individual differences in prior knowledge (e.g., Spiro, 1980) have many implications for learning. That is, learners who lack an existing knowledge base for the new information will have greater difficulty in comprehension and learning

because they have no existing links to which to attach the new information or they have difficulty in accessing those linkages (Brown, 1980).

At the same time, one of the most common problems in teacher education is to persuade teachers that, in fact, students often do have substantial prior knowledge about a subject that is seemingly novel, such as the history of the sea turtle or the conflict between the Indians and the Europeans at the time of Columbus. While students may not have specific knowledge of sea turtles or the nature of this conflict, most students have some knowledge of the sea, of turtles in general, of the life cycle of living things, of the Indians, of the Europeans, and of conflict. Each of these sets of knowledge can serve as a link to the new information.

Knowledge of Strategies Another characteristic of the reader that influences how he or she will comprehend the text is the repertoire of strategies that the reader uses. From reading research, we know that the reader has a repertoire of reading strategies such as skimming and analyzing the titles, subtitles, and paragraph headings (Herber, 1978). From learning strategies research, we know that the learner accesses a repertoire of learning strategies such as visualizing, categorizing, and elaboration to help memorize what is read (Levin, 1976). And from metacognitive research (e.g., Paris, Cross & Lipson, in press; Raphael, 1982), we know (1) that good readers plan, monitor, evaluate, and revise both what and how they will learn, and (2) that teaching students to engage in these activities facilitates learning.

There is substantial research in reading, learning, and metacognition to indicate that there are marked differences between younger and older students, and between low and high achieving students in terms of the learning strategies they use. In fact, it appears that at about grade 4 or 5, high achieving students seem to apply various learning strategies with increasing efficiency to a broad range of reading and learning tasks. Low achieving students do not appear to make this developmental shift without explicit learning strategy instruction (Rohwer, 1971). And there are numerous studies to show that the learning curves of low achieving students, even retarded students, can be greatly enhanced by learning strategy instruction (Jones, Amiran, & Katims, 1985 summary). Further, numerous studies have shown that low achieving students require instruction that is both direct and sustained (Rosenshine, 1983), on the one hand, as well as explicit and interactive, on the other (Brown, Campione, & Day, 1981; Jones, 1980; Reeve & Brown, 1984).

Comprehension Failure

Besides knowledge and strategy deficits, problems of comprehension may arise from many other sources related to the reader. Not surprisingly, the definition of comprehension problems varies greatly with the research. Spiro (1980) identifies problems relating to lack of prior knowledge, individual differences in cognitive capacity, and processing efficiency. Rumelhart (1980) refers to three problems of access: (1) lack of available knowledge structures, (2) inadequate clues for effective retrieval, given the reader's acquisition of specific knowledge structures, and (3) the wrong interpretation of the meaning. Guthrie (1973), for example, distinguishes between a deficit model (lack of prior knowledge) and a difference model (lack of match between the mode of presentation and the learning style of the learner).

Additionally, comprehension failure may arise from specific processing problems. Adams (1980), for example, describes problems of processing relating to recognition, syntactic processing, and semantic processing. She also refers to the problem of limited cognitive capacity, the notion that the learner can only focus on so many things at once. This means that the instruction should be designed to help the learner focus on aspects of the text or problem that are most relevant and useful. And numerous researchers explain retention problems as a function of depth of processing, or lack of it (e.g., Weinstein & Underwood, 1985).

Levin (1976) takes a somewhat different perspective. He argues that some students are likely to learn regardless of the nature of the content, mode of presentation, or task. Others are not likely to learn under any circumstances. The vast majority, however, depend heavily on mode of presentation and other external factors. If their preferred mode of learning is visual, for example, they are more likely to learn if the mode of presentation is visual, rather than oral. It is also conceivable that differences in attention and motivation greatly affect cognitive processing and, therefore, student achievement (Wittrock, in press).

Additionally, students may have a host of specific problems that affect comprehension. The effects of impulsivity, for example, have been well documented. That is, some students allow natural language associations (Auchenbach, 1969, 1975) to structure their responses, rather than thinking through the problem systematically. Also, MacGinitie and his colleagues (e.g.,

Maria & MacGinitie, 1982) refer to readers who have problems in altering their hypotheses to fit new information.

Part 4 Characteristics of the Text

What are the characteristics of the text that influence comprehension? The answer involves two sets of research: (1) research on the nature and quality of textual materials used in classrooms and (2) research on instructional design that influences the use of textual materials.

Characteristics of Textual Materials

Effects of Text on Comprehension and Recall Two strands of research suggest that the organization and quality of the text has a substantial impact on comprehension and recall. First, there is research on text organization. In the late 1960s, Frase (1969) initiated a series of studies devised to investigate the effects of different types of passage organization on the amount recalled and organization of recall. A review of this series nearly 10 years later (Shimmerlik, 1978) concluded that organized texts markedly influenced the total amount recalled, and that the type of organization—specifically redundancy of structural features—influenced the organizational structure of the text. Significantly, research in reading paralleled research in learning. Meyer (1982; Meyer, Brandt, & Bluth, 1980), using various types of school-relevant passages, also found that students' recall was influenced by the organizational structure of the passage, especially signalling devices, or text markers such as "whereas," and "because" embedded in the text. Further, the inclusion of such devices could markedly increase comprehension and recall for low achieving students. More recently, M. Graves (1985) has found that style can influence comprehension markedly.

Considerate and Inconsiderate Prose Texts Extensive research conducted largely at The Center for the Study of Reading at the University of Illinois at Urbana, has shown that existing commercial materials often lead to problems of comprehension because they are lacking in the use of appropriate connectives, pronoun reference, and signalling devices that help students comprehend the meaning of the text. T.H. Anderson and Armbruster (1984) distinguish between "considerate" and "inconsiderate" texts. The latter are texts that hinder or prevent comprehension because they are so poorly written and are therefore

inconsiderate to the reader. Considerate texts include various features that are intended to help readers learn. Anderson and Armbruster define four characteristics of considerate text. They are: (1) appropriateness—text structure that is appropriate to the author's purpose; (2) cohesiveness—the presence of text markers, connectives, and pronouns that help identify the text structure and the flow or arrangement of ideas; (3) unity—the absence of irrelevant information and remarks; (4) age appropriateness.

Research on text design (e.g., Duchastel, 1982; Hartley, 1981) identifies additional features to help the reader learn:

- (1) before the passage—the use of reviews, previews, advance organizers, graphics, titles, subtitles, and paragraph headings to emphasize the macrostructure or overall organizational pattern;
- (2) within the passage—labels, underlining, boldfacing, italics, boxes, marginal notes to identify and emphasize important information from segments of the text;
- (3) after the passage—summaries and graphic organizers to help the students select important information and integrate information from diverse segments of text.

Considerate and Inconsiderate Graphic Texts The term graphics refers to pictures, diagrams, tables, charts, maps, graphic organizers, and so on. Of these, pictures are used far more frequently than any other type of graphic. In fact, according to Friedman and Tinzmann (1984), graphics were approximately 27-36 percent of the text in four middle grade social studies texts. Until recently, there was considerable debate regarding the effect of pictures and other graphics on comprehension of prose text. Some studies found that they were distracting; others found that they did facilitate comprehension. However, three reviews of these studies (Alesandrini, 1984; Levin, 1982; Schallert, 1980) present a consistent picture (pun intended). Generally, if the meaning of the picture is an integral part of the meaning of the prose text, then illustrations seem to facilitate comprehension. Additionally, a review of graphic organizers (Moore & Readence, 1984) indicates that their effect on comprehension is variable. They seem to have the greatest impact when constructed with student involvement after reading. Further, research on spacing (e.g., Hartley, 1981), suggests that placement of illustrations is important; it is disruptive to reading if they are not adjacent to the text to which they refer. Given the importance of graphics, Jones, Friedman, Tinzmann,

and Cox (1984) have argued that graphics are text. More specifically, they show how graphics contain most of the elements that characterize prose text and that graphics texts may be considerate or inconsiderate in much the same ways as prose texts. Friedman and Tinzmann (1984) have applied these criteria to social studies texts and found that there are marked differences in the considerateness of graphics. Now that these operational definitions are available, it is hoped that researchers, curriculum developers, and teachers will pay more attention to how students process graphics, and how they can be used more effectively to aid comprehension.

Text Conditions Another characteristic of the text that is critical to comprehension is the concept of text conditions. This concept comes from research that originates from Pearson and Johnson (1978). They argued that questions should not be classified without understanding the relationship between the questions and the answers. Raphael and Pearson (1982) define three types of question/answer relationships (QARs). Some QARs are **text explicit** in that the answer is given explicitly in the text. Other QARs are **text implicit** in that the answer is partly given in the text, but the reader must make inferences in order to determine the answer. Finally, some QARs are **text inadequate** in that the answer is not clear from the text, so the reader must use prior knowledge or another source. Note: The term text inadequate is mine. The original term used by Pearson and Johnson was "script". I prefer text inadequate because the meaning of script is not immediately clear and because the word script assumes that the only location of the answer is in the student's head. In fact, the answer may be located elsewhere, such as in another textbook, a lecture, a film, or whatever.

Two sets of research on questions in the text are relevant to comprehension. First, making students aware of QARs has improved comprehension in several studies conducted by Raphael and Pearson (e.g., 1982). In each of these studies, students were taught the three QARs and were asked to classify the answers as being "right there" (text explicit), "search and find" (text implicit), or "on your own" (text inadequate). Second, research on adjunct questions (questions or statements inserted in the text before, in, or after the text) indicates that such questions do indeed have an impact on cognition (André, 1979; Hamilton, 1985). Generally, questions/statements which refer to main ideas tend, not surprisingly, to increase comprehension of main ideas, but not necessarily comprehension of details. The reverse is also true. Further-

more, inserted questions or statements that resemble test questions may increase achievement dramatically (Ellis, 1979).

Instructional Design

Sustained Direct Instruction on Higher Order Objectives There is an apparent contradiction in research analyzing instructional design. On the one hand, numerous researchers have shown that available instructional materials are fragmented and heavily focused on lower order objectives (Durkin, 1984; Osborn, 1984). What is the research base for traditional skills curricula, and what evidence is there that it has negative or positive effects? Seemingly, traditional materials reflect traditional learning theory which assumes that the learner can assimilate only relatively small chunks of new information at one time (Miller, 1956), and that learning requires spaced, rather than massed, practice (e.g., Hintzman, Summers, & Block, 1975). While both of these principles are true, they emerged from research paradigms consisting almost entirely of repeated practice rather than direct instruction. However, traditional developers applied these findings to instruction. Consequently, traditional materials are devised to present increments of instruction that are very small and spaced over many units and/or spiraled over a period of years, only gradually progressing to higher order objectives. These features of traditional instruction largely explain why cognitive researchers argue that commercial texts are fragmented and characterized by "mentioning" rather than sustained instruction. Many researchers such as Durkin and Osborn have argued that the poor quality of instruction in traditional materials is a major cause of low achievement in schools.

What evidence is there for this position? Actually, much of the thrust against traditional instruction comes from analyses of textual material, uses of instructional time, and teacher use of materials, rather than solid data on student achievement, though it is widely assumed in many research quarters that the poor quality of instructional materials is strongly associated with declines of student test scores. Also, many theorists (e.g., Campione & Armbuster, 1985) argue that skills programs are antithetical to recent concepts of intelligence and cognitive growth.

At the same time, there seems to be considerable evidence from effective teaching research (e.g., Rosenshine, 1983) and effective schools literature, that structured school curricula and individual lessons are associated with

high student achievement. Initially, the two points of view appear contradictory. Yet a close examination of the research suggests that they may not be contradictory. Three points are relevant here. First, in effective schools research, direct instruction and structured school curricula may indeed yield high student gains, compared to traditional school curricula, which are poorly defined and loosely organized.

Second, Stedman (1985) has re-analyzed studies of effective schools and found that two types of curriculum design predominated: highly structured skills curricula which characterized most schools and a broad-based curricula emphasizing reading and diverse literature. However, the structured curricula in many of the schools under study were typically one or two specific research-based programs that provided sustained direct instruction and some focus on higher order instruction. Therefore, they were not traditional materials.

Third, Jones and Spady (1985) analyzed successful mastery learning schools and found that all of those studied were characterized by the use of high quality instructional materials and curriculum designs that provided effective solutions to the problem of instructional delivery. Thus, it would seem that the success of these programs may not be attributed to the fact that they reflect mastery learning or that they are structured curricula. To the contrary, their effects may be due in large part to their quality of instruction and good management (see also Levine, 1985).

In the light of these considerations, there is a strong case for sustained instruction focusing on higher order objectives. Further, there is a national thrust to rewrite reading objectives to reflect recent research on reading and thinking. Tierney (1984), for example, suggests that curriculum designs emphasize objectives that will relate to (1) the various stages of reading (before, during, and after), (2) the development of specific (higher order) comprehension strategies such as networking and mapping to help understand the relationships between ideas, and (3) recognition of text characteristics such as the author's organization of ideas. Other sets of higher order reading objectives have been reported by Wixson and Peters (1984), Courtland et al. (1983), and Winograd and Osborn (in press).

Two-Dimensional Sequencing These assumptions about curriculum objectives require new principles of instructional sequencing. Specifically, it would seem that sequencing should have two different dimensions: vertical sequencing,

and horizontal sequencing (Jones, Friedman, Tinzmann, & Cox, 1984). **Horizontal sequencing** refers to the order of instruction between a series of units or chapters. There are two types of horizontal sequencing. First, instruction oriented to learning to read may be **skills driven** in that easier skills should be taught before more difficult skills, given that the content of the texts to be read can be sequenced to flow from easy to difficult. It is also assumed in exemplary skills-driven instruction that the ultimate goals of instruction are to understand the meaning of what is read or to solve the problem at hand. Skills-driven instruction is most appropriate for language arts programs and adjunct study strategy courses, and it is imperative in such courses for the teacher to involve students in extensive applications of specific strategies and training for transfer to content courses.

Second, instruction oriented to reading to learn literature, content area subjects, or vocational skills should be **content driven** in that the strategy/skills instruction is a means of comprehending the meaning of the text, or understanding why things work the way they do. This distinction has important implications for sequencing instruction, especially in texts which may be inherently complex and comparative from the outset, like history and biology texts. In such instances, sequencing strategy instruction from easy to difficult is inappropriate. However, it is crucial to begin the instruction with strategies that are appropriate to the text structures, whether they are simple or not. Moreover, content-driven sequencing begins by establishing the content to be learned in each lesson or unit. This is in marked contrast to the procedures for sequencing instruction for skills-driven courses.

Vertical sequencing refers to the order of instruction within a given lesson or unit. Two types of information may be sequenced vertically: content and instructional format. Content may progress from simple to complex, concrete to abstract, explicit to implicit, familiar to unfamiliar, and short to long. Instructional sequencing refers to the specification of instructional activities for before, during, and after reading a given segment of text or solving a problem. The different strategies that are appropriate for each phase of comprehension and learning are discussed above and will not be discussed further here.

Curriculum Alignment Exemplary instructional materials are characterized by curriculum alignment (Brown, Campione, & Day, 1981; Savard & Cotton, 1982). That is, there is a direct relationship between the objectives, the instruc-

tional materials, and tests. Having said this, it is important to note that there is some disagreement among researchers and practitioners about how much alignment is healthy and appropriate. On the one hand, it is unfair to test for information and skills that have not been taught. On the other hand, there are proscriptions in many quarters against teaching to the test too closely.

Another debate regarding curriculum alignment is the criterion- vs. norm-referenced test issue (National Institute of Education, 1980). Criterion-referenced tests tend to test isolated skills. This tends to drive instruction toward teaching isolated skills, and rarely emphasizes demonstrating that the student understands what is read and can apply new learning independently. At the same time, while norm-referenced tests assess general comprehension, they often do not test what is taught, and both criterion-referenced and norm-referenced tests may focus on lower order objectives. Moreover, since the norming process assures that half the students will be defined as average or below, regardless of the level of attainment for each grade level, norm-referenced tests should not be used to assess individual progress. Rather, they are most useful for assessing whole populations, school systems, or programs.

Remedial Instruction Good instructional materials may include several features that are alternatives or additions to the initial instruction. For example, the materials could regularly include alternate modes of presentation (e.g., visual/verbal) to facilitate comprehension for students with one preference or the other. Additionally, instructional materials could provide instruction to deal with specific types of comprehension problems such as impulsivity or the failure to modify hypothesis to fit new information.

However, the most important issues regarding remedial instruction are the assumptions that low achieving students require basic skills instruction and obversely that they cannot benefit from higher order instruction. There is considerable reason to reject both assumptions. First, there is ample evidence that low achieving students can benefit greatly from direct instruction focused on higher order objectives (Jones, Amiran, & Katims, 1985; Brown, 1985; Reeve & Brown, 1984; Pearson, 1985; Weinstein & Underwood, 1985). Second, D.P. Resnick and L.B. Resnick (1985) argue that programs specifically for low achieving students are often watered-down curricula which have less value in school funding and attention, compared to honors programs. Third, there is evidence that low achieving students suffer in terms of self concept and achievement when they receive low level instruction (Commision on Reading, 1985).

Part 5 Characteristics of the Context

Traditionally, in schema-theoretic literature, context is defined largely in terms of the nature of the task and purpose for reading (e.g., Brown, 1985). Undoubtedly, these are powerful variables which do indeed influence reading rate, reading and study strategies, planning, and so on. Other context variables are the amount of information available to the reader (e.g., Bransford & Johnson, 1972) and the cultural background of the reader (e.g., Heath, 1982).

Yet another set of context variables was defined by Jenkins and described by Brown, Campione, and Day (1981) in a model called the tetrahedral model. This model identifies four key variables that they feel the researcher must address in training studies: the characteristics of the learner, the criterial task, the nature of the materials, and the learning activities themselves. More recently, Brown (1985) and others (e.g., Mosenthal, 1983) have focused on the role of the teacher, and increasingly reading researchers (e.g., Commission on Reading, 1985) are referring to problems of delivery and many of the variables that are characteristically the focus of research on teaching such as grouping and pacing. This merger of research on reading and classroom practice is encouraging. While many of these variables are important, two sets seem particularly noteworthy: the role of the teacher and the problem of instructional delivery, i.e., the articulation of the teacher, the student, and the materials.

Teacher Roles

Traditional Roles Much of research on teaching has been devoted to defining three teacher roles. First, there is the role of the teacher as manager (e.g., Good & Brophy, 1984). And there is no doubt that managing of behavior problems, establishing high expectations for all students, providing fair treatment and access to learning opportunities are among the key classroom factors that influence learning because they influence attention and motivation as well as actual opportunities for learning and self concept. Second, there is the role of the teacher as executive, making literally hundreds of decisions regarding time and timing, content, pacing, grouping, and instructional strategies (e.g., Berliner, 1982).

More recently, researchers have defined a third role of the teacher in terms of functions that focus directly on instruction. Research on teaching

offers two different constellations of functions of teaching during instruction. According to Rosenshine (1983), teaching is most effective when it involves direct instruction. Specifically, this includes presenting examples, teacher explanations, modeling, questioning, checks for understanding, reviews and reteaching if necessary, guided practice and independent practice. Alternatively, Good and Brophy (1984) describe more open, discovery methods of teaching. In these methods, the teacher seeks to gear content, instructional time, pacing, and grouping to the needs of individual students. Open methods also involve more student-centered interactions.

Cognitive Teacher Functions Research on student cognitive processing raises the question: What is the role or function of the teacher in facilitating student cognitive responses? Clearly, mediating cognitive responses involves any or all of the instructional functions of the teacher. Yet it is apparent that student cognitive processing involves something more than direct instruction or discovery methods. The literature on student cognitive processing is confusing with regard to the role of the teacher.

On the one hand, there are theoretical statements which see the student's cognition of the teacher behavior as the mediating event in student cognitive processing in the tradition of verbal learning research on mediated learning experiences (e.g., Bugelski, 1974; Kendler, 1972). Thus, Winne and Marx (1983), for example, state that the effects of teaching on learning "are mediated by" the students' behavior and thoughts during instruction (p. 3). And there is no question that student cognition of teacher behaviors is a critical link in the flow of information from teacher to student processing to student outcome. The teacher's behavior cannot have the intended effect unless the student is aware of its intended meaning and is able to act on it accordingly. Yet, the image of the teacher in this conceptualization seems fundamentally passive; he/she is merely "there," almost as a catalyst for student cognitive processing, rather than an active agent in causing student cognitive processing to occur.

The image of the teacher in the theoretical statements above conflicts with actual descriptions of teacher behaviors from research on teaching (e.g., Duffy, Rochler, & Rackliffe, 1985; Winne & Marx, 1983) and from research on cognitive intervention strategies (e.g., Brown & Palinscar, in press; Paris, Cross, & Lipson, in press; Pearson, 1985; Weinstein & Mayer, in press; Wittrock, 1979). In both research on teaching and research on cognitive

intervention strategies, the teacher is very active in guiding the students to think specific thoughts, to link new information to prior knowledge, to use specific processing strategies, to plan and evaluate, to rethink and revise, and to become autonomous in all these behaviors. In these descriptions, the teacher works hard to guide and direct cognitive processes and development.

Both research strands suggest that the role of the teacher in student cognitive processing is that of an active mediator, a mediator who strives to make specific cognitive events occur such as in the definition of mediator given by Feuerstein and Jensen (1980). In their definition, mediated learning experience takes place when the teacher or any caretaking adult "imposes himself or herself between the organism and the stimuli impinging on it and mediates, transforms, reorders, organizes, groups, and frames the stimuli in the direction of some specifically intended goal or purpose" (p. 409). This process includes directed efforts toward autonomous and self-regulating behavior.

This conceptualization of the teacher has the same emphasis on active goal-oriented behavior as the roles of the teacher as manager, executive, or instructor. What differs is a matter of focus. The role of the teacher as manager focuses on student/teacher relations. The role of the teacher as executive focuses on broader organizational issues such as content, the use of time, and grouping. In contrast, the role of the teacher as mediator focuses on actively structuring the thoughts of the student and those aspects of instruction that relate to processing information.

What teacher behaviors help students process information efficiently and effectively? Although it is not within the scope of this paper to review the entire scope of teacher behaviors that facilitate student cognitive processing, the following concepts are noteworthy:

- Comprehension instruction refers to efforts of the teacher to help the student understand the meaning of what is read or the problem at hand. How teachers do this varies greatly depending on the author. Durkin (1985), for example, recommends focusing on efforts to help students understand anaphoric devices, implied meanings, metaphors, punctuation, and signal words. Alternatively, Omanson, Beck, Voss, & McKeown (1984) provide a model of comprehension instruction, using commercial materials, for comprehending whole passages.
- The reading in the content area model includes actively involving students in reading to relate information to specific issues or questions, categorizing, and constructing graphic organizers.

- Others (e.g., Weinstein & Mayer, in press; Wittrock, 1978) focus on teaching students to use specific thinking and study strategies that focus on learning whole passages: elaboration, analogous reasoning, outlining, semantic mapping, and so on.
- Metacognition (e.g., Brown, 1980; Paris, Cross, & Lipson, in press) refers to the process of thinking about learning and controlling the learning process. Accordingly, teachers would teach students to plan, monitor comprehension to identify gaps and select important information, evaluate, and revise.
- Reciprocal teaching is a specific teaching strategy developed by Brown and Palinscar (in press). It involves modeling specific learning strategies, questioning, clarifying, summarizing, and predicting so that the teacher and student take turns at playing the role of the teacher, and over time the student becomes increasingly autonomous in each of the strategies taught.
- Training for transfer is critical in any type of strategy training because there is strong evidence that students tend not to transfer what they have learned unless specifically trained to do so. Brown (1980) especially has shown that cognitive intervention strategies that provide explicit direct strategy instruction and transfer training are far more effective than what she calls blind strategy training. What is important in direct strategy training is that the teacher informs the student what the strategy is, spells out procedures for using it, and provides both guided and independent practice. Thus, there is a progression from teacher-directed behavior to student-directed behavior. Various analysts have outlined the components of this type of direct strategy instruction (e.g., Jones, 1980; Pearson & Leys, in press; Winograd & Hare, in press). Additionally, Brown (1985) and others have referred to this progress from teacher-directed to student-directed as expert scaffolding.

To summarize, there appear to be four distinct roles or teacher functions. The roles of manager and executive play important parts in establishing the atmosphere for learning, the demands of the task, and the actual materials used, but they do not influence cognition directly. In contrast, direct instruction and the role of the teacher as mediator may influence student cognitive processing directly.

Instructional Delivery

The Problem One of the most difficult problems in education involves matching the level of the instruction to the previous achievement of the student (Bloom, 1976). Research from numerous strands—academic learning time, mastery learning, schema theory, advance organizers—all of these emphasize the importance of this match (e.g., Good & Brophy, 1984). If the instruction is

too difficult for the student in terms of prior knowledge or capability to learn, the activity is likely to be unduly time consuming, the teacher and learner are likely to be frustrated with each other and the materials, and the learning will be relatively limited. If, on the other hand, the instruction is too easy, the student is not learning and may become frustrated and bored. If the level of the instruction approximates the level of the student, academic learning time is maximized, the student progresses satisfactorily, and the teacher is elated.

Unfortunately, numerous classroom practices support inappropriate matches, so that often most students in the classroom are not ready to receive the level of instruction that has been assigned to them. Why does this happen? Most classrooms are heterogeneous, because having students of different abilities in one room is consistent with American values for equality and against tracking. Yet the cost of heterogeneity is high. The teacher usually is forced into two poor choices. If the teacher uses the same instructional materials for all students, he/she saves time, but students above and below the level of the materials are typically "turned off" and inhibited in their learning. If the teacher uses different sets of materials for the different levels of ability, then there is not only very low time on task because the teacher can only be with one group at a time, but also students quickly learn that the teacher has different expectations for each group, that their learning opportunities differ according to their group assignment, and that there is considerable stigma and inflexibility associated with being in the lowest level.

Solutions Jones (1982) and Jones and Spady (1985) have identified several solutions to the problem. Some of them involve building organization. Others involve the organization of instruction.

First, building-level solutions. Some schools use pull-out programs to provide compensatory or supplementary instruction, but such programs are often difficult to manage and have limited impact because the student is confused or overwhelmed by the two programs (regular and supplementary). "Walk in" reading, as it is called in some schools, allows students to be grouped heterogeneously for most of the day, but grouped homogeneously for reading and/or math; i.e., students "walk" to the classroom that matches their level of achievement. Team teaching and using government funding to increase the number of aides to the classroom or reduce class size allow teachers to group more effectively.

An altogether different approach to building organization is some type of individualized instruction, but this is so often fraught with problems of management that it is worse than heterogeneous groupings. There are, however, some programs of individualized instruction that provide effective solutions. Slavin et al., (1984), for example, have the students take over much of the testing, monitoring, and record keeping functions of the teacher, thereby giving him/her more time for instruction. Rubin (Rubin & Spady, 1984) defines a different solution. In Rubin's model, there is no classroom as we know it. Teachers teach specific skills in learning stations, while students are tested, evaluated, and reassigned in testing and resource stations. It should be pointed out, however, that both programs are research-based math programs that involve a very high quality of instruction. It seems unlikely that the same solutions would work for reading or content instruction or for courses having a lower quality of instruction, since attaining success in each concept or skill is critical to the flow of instruction.

A second way to approach the problem of instructional delivery involves the organization of instruction. That is, it is possible to organize instruction so that students do not have large deficits in prior knowledge or an accumulation of mislearnings. Mastery learning theory and practice offers various solutions in this category. Bloom (1984) and his students, for example, have devised several ways to identify and pre-teach prerequisite skills and knowledge in hierarchically sequenced courses such as algebra and French. Similarly, Jones, Amiran, & Katims (1985) argue that it is useful to embed prerequisite skills and concepts into each learning unit. Abrams (1983) uses the same reasoning in her training program. She requires the teachers to assess prerequisite knowledge and skills informally before instruction of each unit. Students who have deficits in either are given some prerequisite instruction. Reed (1984) offers two different mastery learning solutions: (1) *overt* teach so that students overlearn before being tested and have good retention, and (2) *pre*test and *re*teach all students in the fall so that students in each classroom begin instruction at the same level.

An alternative solution is offered by well-constructed, research-based computer programs (e.g., Sleeman & Brown, 1982). In such programs, low achieving students can access a variety of tools such as calculators, symbol legends, dictionaries (including synonyms for vocabulary and extended definitions) graphic representations of the text, additional explanation, and

elaboration of the text, lower levels of reading, strategy prompts, reviews, previews, and summaries. High achieving students can, of course, access all of the above as well as enrichment activities, extensions of the text, "brain-teasers", additional assignments, and so on. It is most unfortunate that such programs are not generally on the commercial market because they are so expensive and because many educators do not know of these capabilities of the computer.

In lieu of making the instructional text interactive, interactive teaching of the type described above will function to reduce the knowledge gap between low and high achieving students. While interactive teaching can be used with small homogeneous groups, it was intended to be used with heterogeneous groupings in order to involve students at all levels of achievement in the act of constructing meaning from text. That is, the high achieving students often offer information and strategies that low achieving students lack. Moreover, when low achieving students are expected to contribute and to learn, they may offer insights and novel perspectives that enrich the classroom experience for everyone.

To summarize, there are various ways to solve the problem of matching students' levels of prior achievement to the level of instruction. Some involve changing the reader so that deficits in prior knowledge and learning strategies are decreased. Others involve changing the text or the instructional materials to address those deficits. Still other solutions involve changing the behavior of the teacher. Many solutions involve the reader, the text, and the teacher.

Part 6 Discussion

Summary

The purpose of this paper was to generate a model of student cognitive processing that incorporates research in reading, thinking, teaching, and instructional materials. Reading was defined as a constructive process involving an interaction of the reader, the text, and the context. Connections between reading and thinking were indicated with particular emphasis on the concept of depth of processing. Characteristics of the reader that impact on comprehension are prior knowledge of content and learning/thinking strategies as well as individual differences in such factors as attention, motivation, access, and processing capabilities. Characteristics of the text that influence

comprehension are (1) the quality of the instructional materials and (2) instructional design factors that influence the sequencing and use of materials in the classroom. Characteristics of the context that directly impact on comprehension include the purpose for reading, access to information, and the role of the teacher. The interaction of the reader, the text, and the teacher is summarized in Figure 1.

Insert Figure 1 about here.

Implications

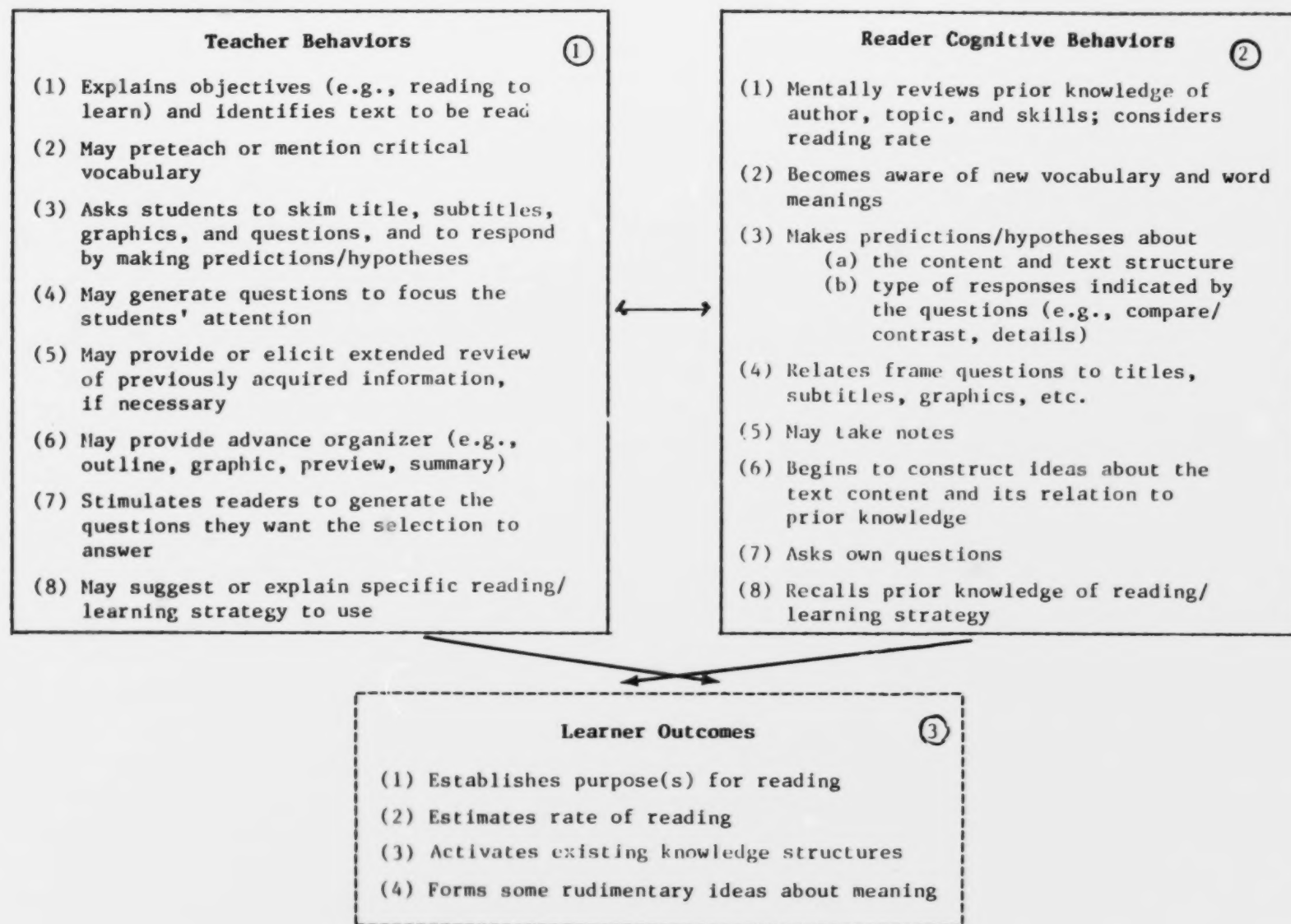
While there are many implications of the conceptual framework presented above, four are outstanding. First, given the importance of the teacher in helping students process text-based instruction, it would be useful to researchers and practitioners alike to use this model to document precisely the role of the teacher as mediator in text-based instruction, i.e., to document precisely what it is that teachers say and do to help students understand what they read in math, reading, chemistry, and other courses.

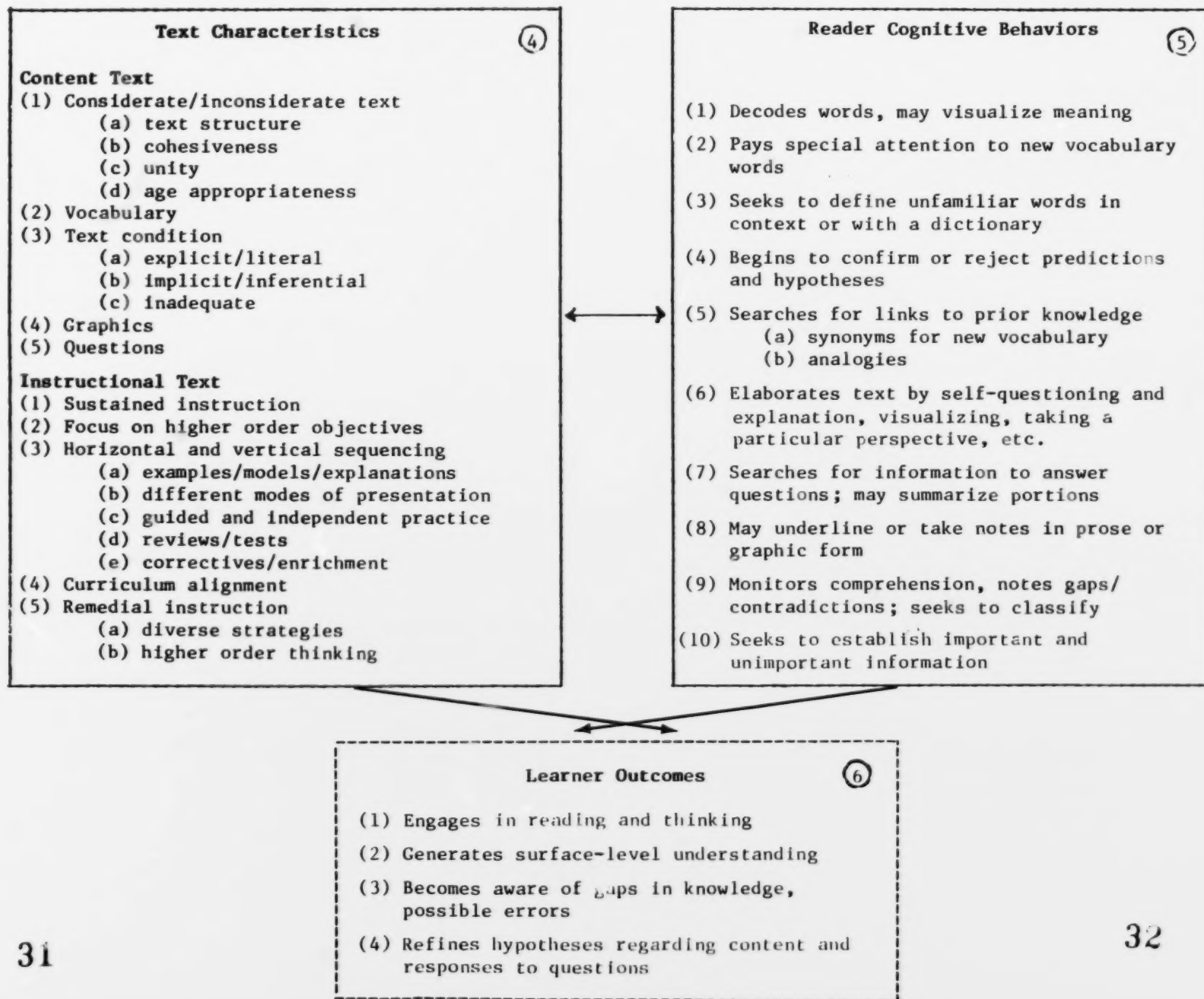
Second, reading to learn, the act of constructing meaning from text, is fundamentally higher order thinking at every stage of comprehending and responding to text. Therefore, it is as critical to define thinking skills with reference to research on reading and instructional materials, as it is to define reading comprehension with reference to research on depth of processing and higher order thinking. It is hoped that the proposed model will facilitate this integration of ideas and data among researchers and practitioners.

Third, the characteristics of instructional design cited here derive largely from the premise that there should be explicit instruction for each phase of comprehension and responding to text. This assumption differs markedly from traditional assumptions about the sequencing and definition of instructional materials made by publishers, curriculum experts, and many researchers. It is hoped that these principles of design and the assumption upon which they are founded can be utilized in practice.

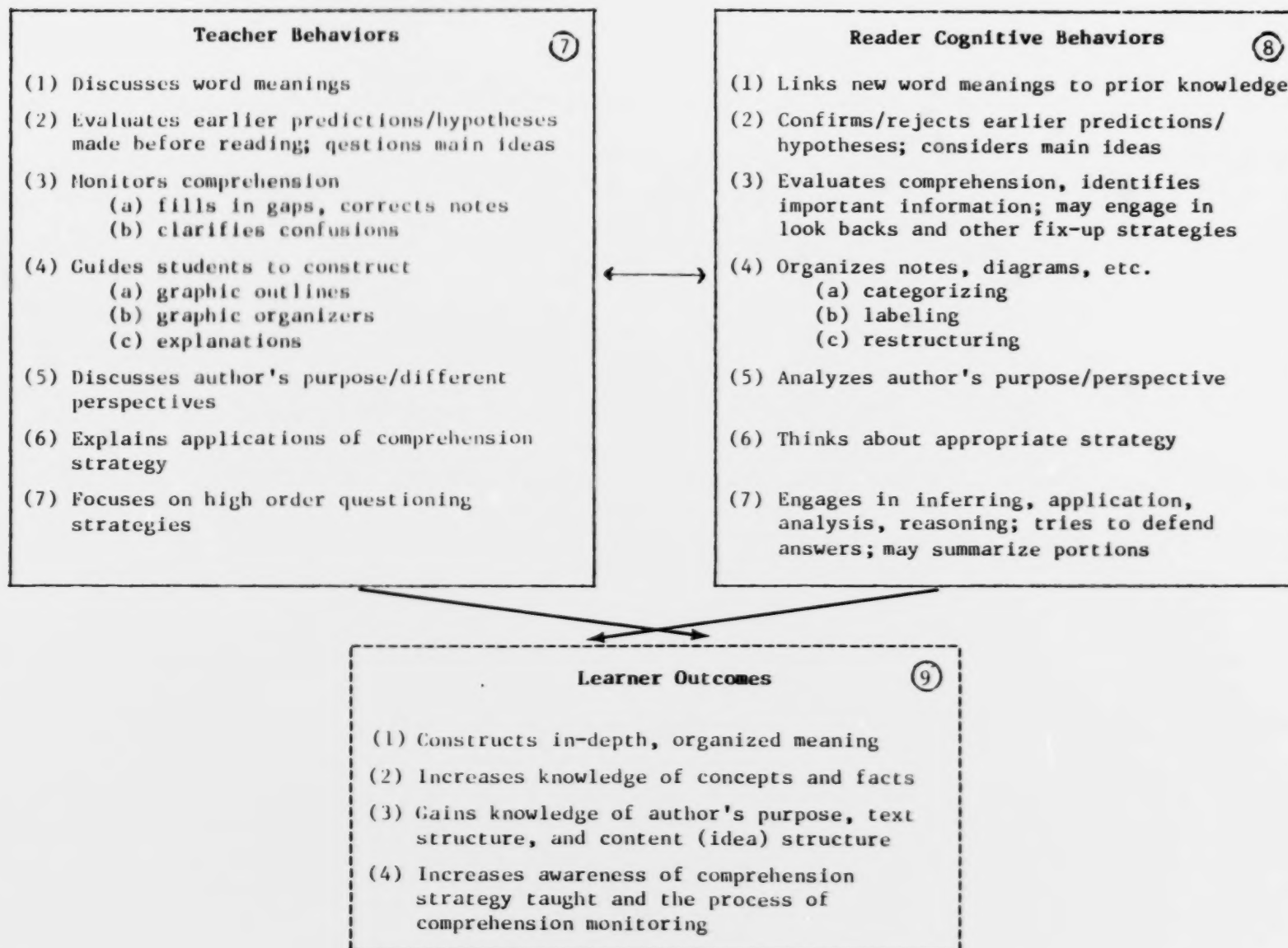
Fourth, traditional intervention strategies emphasize retention, accelerated instruction, decelerated instruction, and remediation using experiential strategies. Many researchers and practitioners assume that comprehension

Stage I. Before Reading/Readiness Processing

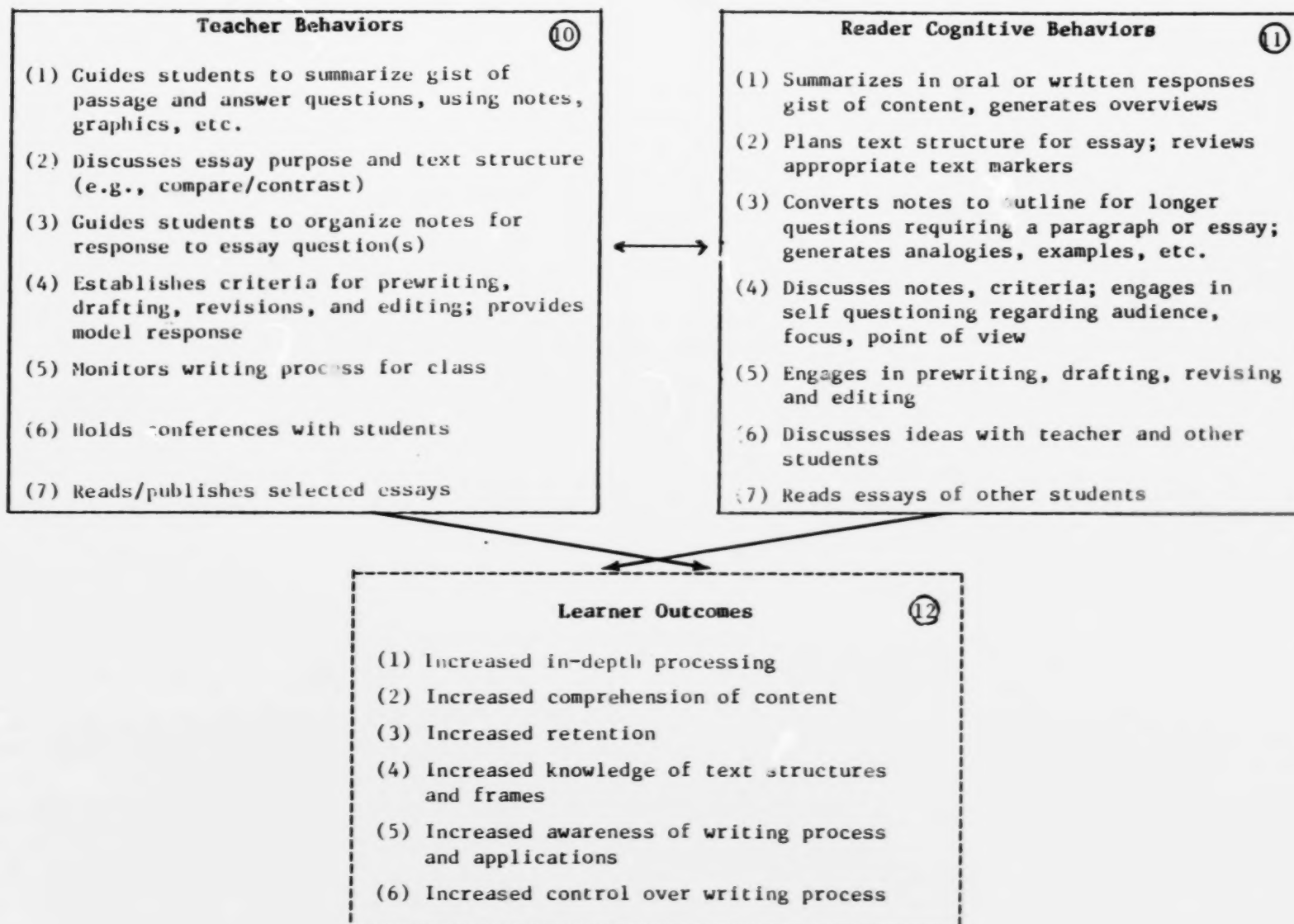




Stage III. In-depth Processing (After Reading)



Stage IV. Response Processing (After Reading)



failure and student achievement result largely from deficits of prior knowledge, lack of attention and motivation, or poorly defined learning difficulties. The implications of this model are that remediation strategies should emphasize cognitive intervention strategies and the role of the teacher as a mediator.

Finally, it may be a long time before instructional materials change substantially. In the interim, it is important for researchers and educators alike to develop effective instructional strategies that utilize existing instructional materials more effectively. Research in student cognitive processing and cognitive instructional strategies offers powerful concepts to fill the void, yet neither research strand defines the role of the teacher or instructional materials effectively. The model presented here seeks to address those gaps and may be useful in the classroom using the existing instructional materials.

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